Using Industry's Own Words to Quantify the Benefits and Challenges of ISO 50001

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Abstract

A growing body of research is beginning to collect and analyze data to understand drivers, benefits, and challenges of implementing an ISO 50001 energy management system. One new data source is the annual Clean Energy Ministerial's Energy Management Leadership Awards program. Launched in 2016, this international effort requires ISO 50001-certified organizations to develop a case study of their implementation experience, using a uniform template. Case studies also include quotes from employees, along with energy and cost savings calculations and information on facility locations and industry sectors. Case studies typically range from 5 to 9 pages in length; 35 case studies were tendered in 2016, and 37 in 2017. To analyze these data, researchers at Lawrence Berkeley National Laboratory employed the method of content analysis, a well-established practice widely used in the social sciences to make sense of qualitative information. This analysis occurs via close reading of each case study and transcription of relevant phrases from the following categories: motivations and goals; role of management and the organization; benefits achieved; keys to success; and challenges. Phrases are then assigned carefully defined "codes" that capture their meaning in order to enable quantitative analysis.

This paper presents results from the content analysis of Energy Management Leadership Awards case studies. While organizations undertook ISO 50001 adoption based on a range of motivations and experienced myriad benefits, commonalities exist. The biggest drivers for ISO 50001 certification are existing values and goals, cost savings, environmental sustainability concerns, government incentives or regulations, and gaining competitive advantage via visibility. This analysis of case studies also reveals that top management engagement can play an important role in successful ISO 50001 implementation, cost saving is the most frequently mentioned benefit achieved, availability of disaggregated and transparent energy data is the number one challenge faced, and obtaining top management support is a critical key to success. Policymakers and others looking to promote ISO 50001 uptake can use these results to highlight benefits and incentives that will resonate well when communicating with industrial facilities.

Introduction

ISO 50001 is an international framework for the structured practice of managing energy. First published by the International Organization for Standardization (ISO) in 2011, ISO 50001 takes a continual improvement approach to energy management. The standard specifies requirements for energy management systems (EnMSs) that enable organizations to deepen and sustain improvements in energy performance. By the end of 2016, ISO 50001 had been implemented at more than 20,000 facilities worldwide by companies seeking to cut operating costs while furthering competitiveness and resilience (ISO 2017). Uptake of ISO 50001 is anticipated to quicken as businesses incorporate energy management into supplier requirements and corporate sustainability strategies.

A growing body of research is beginning to document the drivers for and barriers to ISO 50001 uptake. Fiedler & Mircea (2012) speculated that cost saving is "probably the major driver for the majority of organizations" putting an ISO 50001 EnMS into effect, achieved via lower energy costs and compliance with governmental financial incentives such as those in Germany, which lower electricity and gas taxes. They further suggest that certification "proves a sustainable company strategy…and strengthens its company image," but did not cite any data to bolster their assertions. Similarly, for a range of certified companies contending for Energy Management Leadership Awards, Clean Energy Ministerial (2016) and (2017) presented a collection of employee quotes along with energy and cost savings, facility locations, and industry sectors, but performed no analysis.

Several recently released studies surveyed motivations, benefits, and difficulties associated with ISO 50001 adoption. AFNOR (2015), AFNOR (2017), and Marimon & Casadesús (2017) conducted online surveys of 66, 185, and 57 ISO 50001-certified companies, respectively, which were largely located in Europe. AFNOR (2015) identified the following common motivations: obtaining certification, achieving methodical energy management, cost savings through managing energy, corporate strategy, available subsidies and financial support, and rising energy and/or carbon costs. 65% of organizations saw both financial and non-financial benefits, such as better identifying energy consumption zones to ultimately increase profit margins, prioritizing strategic actions, increasing personnel skill level, and triggering innovation. Building on 2015 findings, AFNOR (2017) concluded that ISO certification increasingly appeals to companies of all sizes, and that many (78%) surveyed facilities are certified in at least one other ISO area, most often 9001 (quality) or 14001 (environment). In descending order of prevalence, common drivers were: financial savings through systematic energy management, meeting or anticipating regulatory

requirements, availability of government subsidies and financial assistance, company strategy, and the need to restructure existing processes. Finally, Marimon & Casadesús characterized the main drivers for implementation as ecological, gaining competitive advantage, and social requirements. They found that positive results from ISO 50001 include monetary savings, motivating other organizations to implement the standard, improved environmental performance, safety, and better overall productivity. Positive attitudes of company staff were critical to successful implementation. Main difficulties were the high cost of certification, data complexity, lack of available resources and leadership commitment, and uncertainty of benefits.

These recent surveys provide important insight into conditions necessary to success for those companies that have already implemented ISO 50001. However, 274 of 308 collective respondents (89%) were located in Germany, France, or Spain, compared to the share of certified facilities in those same nations (51%)[1]. These are all advanced industrial economies embedded in the European Union, and thus may face markedly different conditions for implementation relative to the rest of the world, especially with regard to regulatory and financial incentives. Moreover, from limited information presented, the sampling method of these surveys appears to be neither random nor stratified, precluding high external validity. Ideally, a future random sample of companies that have attempted (and not necessarily achieved) ISO 50001 certification, with greater geographical reach, is required for more robust survey results.

This paper explores the case studies submitted for Energy Management Leadership Awards consideration as a set of qualitative data that can be quantified through content analysis. The dataset developed for this paper draws from companies headquartered around the globe, representing a wide variety of industrial, commercial, and municipal sectors. The questions motivating this study are:

- Why have some companies implemented ISO 50001 certified energy management systems?
- What motivations for, benefits of, and barriers to ISO 50001 certification did these enterprises share?
- What can we learn from these early adopters, and how might policymakers use this knowledge to better target communication materials to other companies in order to increase uptake of ISO 50001?

Data and Methods

Available Data

With limited available information outside Europe on incentives and effects of ISO 50001 implementation, one new data source to draw upon is a collection of case studies submitted by certified companies to gain recognition via annual Energy Management Leadership Awards. The Clean Energy Ministerial's Energy Management Working Group (EMWG) hosted the first awards ceremony in May 2016, with a second following in May 2017. Each year, all participants received an Insight Award, and three received top honours: Cummins, Inc., LG Chem, Ltd., and New Gold, Inc. received the 2016 Excellence Award, with Abu Dhabi National Oil Company, Arabian Cement Company, and Mutua Madrileña as 2017 recipients. To qualify for consideration, ISO 50001-certified facilities or corporations submitted a written case study using a template. Case studies typically ranged from five to nine pages in length; 35 were tendered in 2016, and 37 in 2017. This analysis used all 2016 and 35 2017 case studies; two from 2017 were excluded due to reporting inconsistencies. Table 1 displays all case studies' sectoral and geographical reach, as classified by Clean Energy Ministerial (2016) and (2017). Regions are aligned with UN (2018); manufacturing subsectors and countries are ordered by facility count, then alphabetically.

Table 1. Sectors and countries represented in 2016 and 2017 case studies.

Sector	# facilities	# case studies
Manufacturing*	82	49
Insurance & property management	28	2

Region	Specific countries represented	# facilities	# case studies†
Europe	Spain, Germany, Ireland, Italy, UK, France, Poland, Portugal, Hungary, Latvia	59	19
North America	USA, Canada	57	16

[1] https://isotc.iso.org/livelink/livelink?func=ll&objId=18808772&objAction=browse&viewType=1

Oil & gas production	26	5
Technology & services	26	1
Energy & energy management products & services	21	2
Water & wastewater	8	2
Electric power generation	3	3
Telecommunications	3	1
Municipalities	2	2
Charity	1	1
Financial services	1	1
Freight transportation	1	1
Iron, steel & fabricated metals	1	1
Mining (gold & copper)	1	1
Totals	204	72

East Asia	Indonesia, Philippines, South Korea, Thailand, Singapore, Taiwan	30	20
Western Asia	UAE, Jordan	27	5
Latin America	Mexico, Brazil, Argentina, Chile	12	7
South Asia	India	10	10
Africa	Egypt, South Africa	6	6
Developed Asia & Pacific	Japan, Australia	3	3
Totals		204	86

[*] *Specific manufacturing subsectors represented: general, cement, engines & related technology, automotive, chemicals, electrical equipment, food & beverage, pharmaceuticals, textiles, pulp & paper, acrylic film & battery, aluminium, automotive parts, commercial & defence nuclear, footwear, healthcare (diagnostics), non-metallic mineral product, plastics, and safety equipment*

[†] *Shows the number of case studies with a presence in each country, because some case studies pertain to multiple countries.*

Methodology

The collection of case studies written for 2016 and 2017 Energy Management Leadership Awards eligibility encompass several hundred pages of text, loosely structured by the case study template. One suitable approach to systematically extracting insights from this heterogeneous textual data is known as content analysis, a well-established methodology widely used in the social sciences to make sense of qualitative data by enabling quantitative analysis. Frequently cited recent work covering important methodological considerations are Elo et al. (2015) and Stemler (2015), while two recent applications in the field of energy and environmental management are Nath & Ramanathan (2016) and Herbes & Ramme (2014). The main objectives of content analysis are transparency and a systematic, replicable approach. Drawbacks inherent to this methodology are that analysis of content necessarily entails interpretation, and that it can be difficult to infer hidden or latent content. This particular dataset also contains only successfully certified companies motivated to publicly promote their successes via an awards process, and thus may be biased against a fuller accounting of challenges faced.

The application of content analysis to evaluate the content of these case studies occurs via close reading of each case study and manual transcription of relevant phrases from the following categories of interest: motivations and goals; role of management and the organization; benefits achieved; keys to success; and challenges. These categories were chosen based on their expected relevance to stakeholders interested in boosting the uptake of ISO 50001 energy management systems, and are mapped to corresponding case study headings in Table 2. Case studies were scored by unpaid expert reviewers selected by the Energy Management Working Group, with each section allotted a certain number of possible points. While researchers focused on the case studies headings listed in Table 2, they transcribed relevant phrases throughout all portions of case studies as necessary.

Table 2. Mapping between classes of interest and case study headings.

Content analysis category of interest	Case study heading	# possible points awarded
Motivations and goals	Business Case for Energy Management	5
Role of management and the organization	EnMS Development and Implementation	40
Benefits achieved	Business Benefits Achieved	15
Keys to success	Keys to Success	5
Challenges	Lessons Learned	5

In parallel, researchers created a set of "codes"—short abbreviations of a concept that describes pre-determined and well-defined categories—for each category of interest. Codes identify specified characteristics of each transcribed

phrase, and analysis of these codes can quantify, for example, how often certain motivations or benefits were experienced by participating companies. Some codes were determined in advance via a conceptual framework and literature review of motivations, barriers, best practices, and behaviour related to industrial and commercial energy efficiency. This review included: Luboff et al. (2016), U.S. Department of Energy (2015), Therkelsen & McKane (2013), Straehle et al. (2013), Sullivan et al. (2012), Brun & Gereffi (2011), and Environmental Defense Fund et al. (2011). Other codes emerged via analysis of the first 20% of the 2016 case studies to be transcribed. This approach, known as emergent coding, relies both on existing literature and on using data to guide theory and thus lies between the wholly theoretical and the purely empirical. Developed codes are meant to be mutually exclusive and exhaustive. Further, codes should fit the data, instead of forcing data to fit the codes. While assigning codes unavoidably entails interpretation, definitions should be clear enough to result in high inter-coder reliability, the degree to which independent coders agree on coding assignments.

Next, researchers then assigned each transcribed phrase the applicable three- to four-letter codes; each phrase can be assigned multiple codes if appropriate. One example of code assignment concerns a phrase in the motivations and goals category: "Excellent overall opinion is one of the key performance indicators at [company]. It is a measure of brand health from our customers' perspective. External recognition for EnMS and SEP certification is a key pillar to support overall opinion improvement." This would be coded *PR = improving image and marketing value; brand protection; gain competitive advantage via visibility*. Two researchers independently (blind) coded all case studies, starting with 2016. Initial percent agreement (number of overlapping codes divided by total number of codes assigned) was 70%. In-person discussion and revision of coding definitions then led to overall percent agreement for 2016 and 2017 case studies of 81%. In case of remaining disagreement, a random code among assignments was chosen. Finally, spreadsheets of code assignments were evaluated with custom-built analysis software; analyses are presented in the following section.

Results

Throughout this section, results are presented in bar charts, where the X-axis represents the codes mentioned and the Y-axis indicates the number of times concepts captured by those codes were mentioned across all case studies. The percentage atop each bar is the percentage of case studies mentioning those codes at least once. Figure 1 exhibits all the codes across all categories in aggregate, excepting the codes mentioned in less than 25% of the case studies; the following table provides a general description of each code included in the figure. Note that some of the mentions of the same code could have different or opposite meanings depending on the section in which they appear (e.g., an energy-aware company culture could represent either a challenge or a key to success). This figure is best viewed as the types of considerations most often mentioned across all categories.

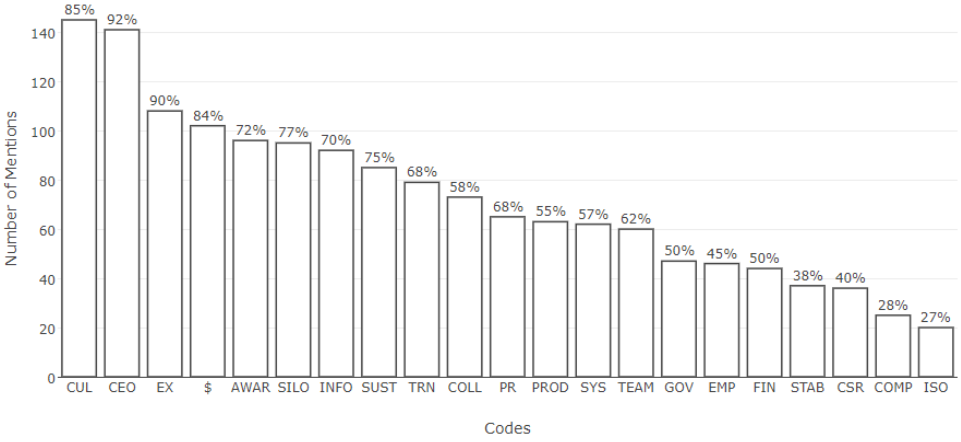


Figure 1. All codes across all categories mentioned at least once in ≥25% of case studies; data includes case study submissions from 2016 and 2017.

Table 3. Description of codes represented in Figure 1.

Code	General Description
CUL	An energy-aware company culture

CEO	Engagement and support of upper-level management
EX	Existing goals and values; previous energy efficiency achievements
$	Cost savings; return on investment
AWAR	Employee awareness through communication and transparency
SILO	Overcome organizational silos *(e.g.*, cross-departmental teams, share best practices)
INFO	Reliable and accurate energy metering; understand SEUs and identify facilities with largest impact
SUST	Environmental sustainability
TRN	Organize and sponsor relevant trainings
COLL	Collaborate with government, utility, or other outside entities for funding and knowledge
PR	Visibility, marketing value, and company image
PROD	Increase productivity (*e.g.*, via less plant downtime or lowering energy intensity)
SYS	ISO 50001 provides a structured framework and tools to achieve energy goals
TEAM	Dedicated energy teams and appointment of internal champions with clear accountability
GOV	Government incentives or regulations; partnership with organizations such as UNIDO
EMP	Employees feel empowered and rewarded to take action
FIN	Dedicated funds and resources outside individual groups' budgets; financial approach beyond simple PBP
STAB	Improved economic stability; reduced risk/exposure to energy costs
CSR	Corporate social responsibility; consumer, shareholder, or buyer pressure to be green
COMP	Increase competitiveness; business performance-related issues
ISO	Previous implementation of other ISO management systems (or similar)

Figure 1 demonstrates that the content analysis of hundreds of pages of written case studies yields quantifiable results from a rich but qualitative dataset. Further examination reveals that this chart contains 21 of 66 total unique codes, meaning that approximately one third of unique codes developed were mentioned by at least one quarter of the pool of 2016 and 2017 case studies. Also, the number of mentions (on the Y-axis) generally—but not always—tracks in step with the percentage of case studies that mentioned each code at least once (above each bar). Divergences are attributable to case study authors stressing certain salient points more than once, and/ or because the phrases encapsulated by certain codes lent themselves to more detailed textual description.

Considering in aggregate all the codes in Figure 1 and Table 3, an energy-aware culture, engagement and support of upper-level management, existing goals and values, and cost savings were among the topics most discussed in all the case studies. The number of mentions for an energy-aware culture and engagement/support of upper-level management clearly outpaces those of existing goals and values and cost savings, yet the percentage of case studies mentioning each code ranges narrowly from 84–92% for these most common codes.

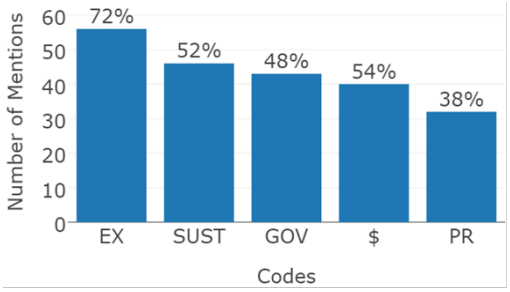
Each subsection below presents the top five codes in terms of the most number of mentions within each category, which are also the top five codes by percentage of case studies mentioning those codes. The text in each subsection attempts to accurately represent salient points from each figure, and quotations from individual case studies further bolster interpretations of these data, using organizations' own words.

Motivations and Goals

The results in Figure 2 suggest that among the most important motivations for implementing ISO 50001 energy management systems are existing energy goals and values, environmental sustainability, government regulations and/or incentives, cost savings, and improved company image. Existing energy goals and values are the most common driver, both in terms of absolute number of mentions and percentage of case studies (72%). Environmental sustainability, government regulations and or/incentives, and cost savings cluster together when it comes to both number of mentions and percentage of case studies referencing these motivations (48–54%). Still among the top five of fourteen possible drivers identified, but exhibiting fewer mentions among fewer case studies (38%), is improving company image and marketing value.

Prime candidates for ISO 50001 are thus those companies that have already articulated an energy vision, taken steps to improve operational energy efficiency, or include environmental sustainability among their core values. Similarly, organizations with existing energy and sustainability goals and values can look to ISO 50001 as a way to achieve those aims. Policymakers may want to target communication materials to these companies in order to accelerate uptake of ISO 50001, especially by emphasizing these systems as a proven and systematic path to the realization of

existing energy goals. Policymakers in a position to create incentives or mandates should note that about half of the companies who submitted 2016 or 2017 case studies mention government regulations and/or incentives as a motivating factor in their decision to pursue ISO 50001 certification. Some indicated that they acted in direct response to government regulations such as India's Perform Achieve Trade (PAT) Scheme, which set up a market for energy-efficiency certificates required in energy-intensive sectors, or Indonesia's Energy Management Regulation No. 14/2012, which directs energy consumers exceeding 600 tonnes of oil equivalent to practice energy management. Others, such as firms headquartered in Europe, adopted an ISO 50001 EnMS as one strategy to reduce greenhouse gas emissions to meet national or EU targets, while others chose to act in response to voluntary government incentives or in advance of anticipated government regulation.



Code	Description
EX	Existing goals and values; previous energy efficiency achievements
SUST	Environmental sustainability
GOV	Government incentives or regulations; partnership with organizations such as UNIDO
$	Cost savings; return on investment
PR	Improving image and marketing value; brand protection; gain competitive advantage via visibility

Figure 2: Motivations and goals for implementation of ISO 50001.

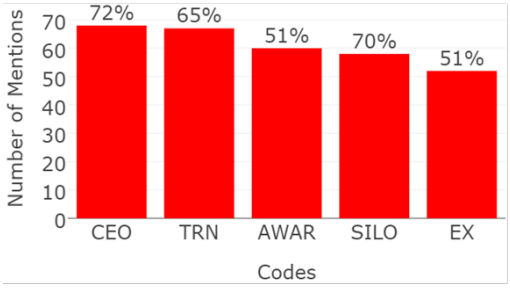
Although cost savings were mentioned as a motivation less often than existing energy goals and values, the former was the most commonly mentioned benefit of ISO 50001 energy management systems (see Benefits Achieved section). Stakeholders may thus wish to emphasize the primacy of cost savings as a proven benefit to motivate organizations deciding to pursue ISO 50001 certification. Finally, in the set of case studies, improving company image was often linked to improving competitiveness. For example, the case study for Aberdare Cables stated, "We are setting ourselves apart from our competitors by leading the way", while HARBEC, Inc.'s case study reads, "HARBEC nurtures its green image, which delivers growing value in domestic and international markets." Such experiences may help convince firms that publicizing ISO 50001 implementation goes beyond positive press to strategically position certified organizations above their competitors.

Role of Management and the Organization

Because ISO 50001 is a framework integrated into the management practices of an organization or facility, the role of management and the organization is paramount in its successful implementation; as such, it was given its own category in this analysis. As seen in Figure 3, obtaining top management support or corporate-level commitment for ISO 50001 is first in this category, both in terms of number of mentions and percentage of case studies. Next, the essential role of the organization in arranging and delivering relevant trainings comes second in terms of number of mentions, but is outpaced by the necessity of overcoming organizational silos when it comes to percentage of case studies (65% vs. 70%). The higher number of mentions for training may be attributable to the fact that many case studies described various types of trainings aimed at different actors within companies (e.g., certified energy managers, energy team members, management, and process workers). Finally, actively taking measures to increase employee awareness is highlighted by the same share of case studies (51%) as is having energy management as an existing goal, or having an existing framework (e.g., ISO 14001 [Environmental Management] or similar) that can readily be modified to accommodate an EnMS, though this latter theme saw fewer mentions than did employee awareness efforts.

This analysis suggests that securing the support of higher-level management has the most bearing on a successful ISO 50001 EnMS. Generally, management support was critical to ensure that planning and implementation processes were well-resourced, roles and responsibilities on the energy team were clarified, and that energy management became integrated into company culture. One example of fostering the latter was mandating a 5% weighting for energy management and conservation in all business units' balance score cards, as at Emirates National Oil Company Retail Operations & Marketing. A code mentioned by almost as many case studies pertains to overcoming a silo mentality by sharing best practices among facilities or constituting an energy team that bridges departments to benefit the larger organization. For example, at 3M, "the wide-ranging inclusion of key team members across department lines…provided great benefit to the implementation process. This included increased EnMS awareness and leverage of EHS team members already engaged with ISO 9001 and 14001."

In addition, an organization can positively influence the implementation process by providing necessary training, actively taking steps to increase employee awareness of energy efficiency, and linking ISO 50001 adoption to existing goals and values that support sustainability and energy efficiency measures. Training topics ranged from user training on energy awareness, energy behaviour, and details of ISO 50001, to full-blown energy manager certification or expert training of enterprise energy managers. Recipients of training were varied as well: top managers, energy team members, all employees, and employees whose daily practices most affect plant energy consumption. Such training often was provided by third parties like consulting firms or government programs (e.g., UNIDO or the U.S. Department of Energy's Superior Energy Performance program). Examples of specific steps taken to increase energy awareness are trainings, electronic campaigns conveying practices put into place via ISO 50001 and resultant energy savings (e.g., e-mails, blog posts, newsletters, and periodic reports), visual communication materials (e.g., posters that reinforce the benefits of energy management), annual energy awareness weeks or energy fairs, and energy-saving tips affixed to employee badges.



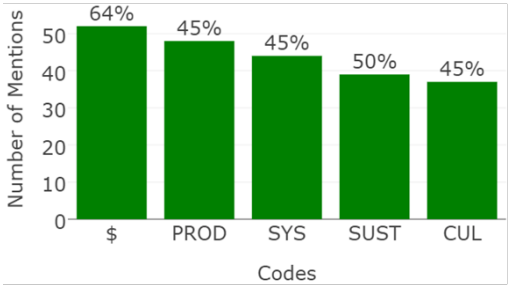
Code	Description
CEO	Top management support or corporate-level commitment
TRN	Organize and sponsor relevant trainings
AWAR	Actively take measures to increase employee awareness through communication and transparency
SILO	Overcome organizational silos (*e.g.*, cross-departmental teams, share best practices among facilities)
EX	Energy management as an existing goal; existing ISO 14001 or similar framework(s)

Figure 3: Role of management and the organization in successful ISO 50001 implementation.

Finally, management often positioned ISO 50001 as the preferred option to achieve existing energy-related values, especially given the presence of existing management systems with a focus on continuous improvement. These were regularly cited as critical to quickening and simplifying ISO 50001 execution. For example, FCA US LLC's Dundee Engine Plant set up their EnMS in one year, commenting "Regarding the fact that the EnMS was born integrated with the other normalized systems already existing in the company, namely ISO 9000, ISO 14000 and OHSAS 18001, the work of implementing operational control measures was facilitated. There was only a need to reinforce some existing practices…to strengthen [their] energy dimension." Ultimately, the insights that arise from these case studies in terms of examining the role of management and the organization can be used by interested companies to improve their own implementation processes, as well as by stakeholders who may wish to further develop toolkits or customize outreach materials.

Benefits Achieved

Although cost savings were identified in Figure 2 as only the fourth-most important motivation for adopting ISO 50001, Figure 4 demonstrates that 64% of organizations characterized reduced cost as the most important benefit seen. The benefits next most frequently mentioned in case studies were increased productivity, systematizing energy management, improved environmental sustainability, and a stronger company culture—with 45–50% of case studies noting these. Here, increased productivity is defined as unit of output per unit of input, and can arise from less plant downtime, greater plant capacity, better energy intensity, or time and/or resource savings gained from automating processes or data collection. Case studies most commonly referenced environmental sustainability with respect to reducing greenhouse gas emissions. Each of these benefits were similarly mentioned as motivations to implement ISO 50001 by some companies, although only cost savings appears in the top five across both categories.



Code	Description
$	Cost savings; return on investment
PROD	Increased productivity via less plant downtime, higher capacity, better energy intensity; time/resource savings via automation
SYS	Established process, tools, and consistency for managing energy and data; good methodology for energy review and planning
SUST	Improved environmental sustainability; increased use of renewable resources
CUL	Better employee motivation; strengthened company culture; built culture of continuous improvement

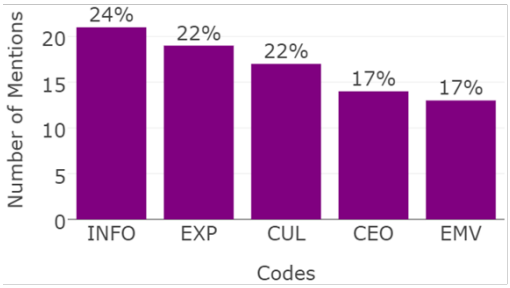
Figure 4: Benefits to organization post-implementation of ISO 50001.

Cost, energy, and carbon savings for participating firms are quantified in Table 5. Sergio Alcantria from Arabian Cement Company found that "Reducing energy use makes perfect business sense as it reduces costs, reduces greenhouse gas emission[s] and help[s] with security of energy supply by reducing dependency on imported energy sources." Going even further, 3M's case study summarizes multiple benefits (cost savings, increased productivity, and systematizing energy management) as follows: "The opportunities to streamline the implementation process through corporate leadership and with multiple plants working as cohorts through our enterprise-wide certification provided significant benefits in terms of time savings, cost savings, and sharing of best practices." Additional benefits of rendering energy management more structured and systematic through the framework of an ISO 50001 EnMS were partially captured by Steve Sacco at Schneider Electric: "The ISO 50001 and Superior Energy Performance frameworks not only build upon our energy management systems, but also help us drive consistency and performance improvements across our locations." Similarly, José Luis Vasquez at TNT Chile Limitada stated, "The ISO 50001 EnMS gave us the structure and tools but overall, the systematicity to focus our efforts and achieve results never seen before."

Another top benefit mentioned by nearly half of the organizations that submitted case studies is encapsulated in the multi-dimensional code CUL: improving employee motivation, strengthening company culture, and forming a culture of continuous improvement. It is important to note that promoting a culture of energy efficiency awareness was identified in 47% of case studies as a key task for management and the organization for facilitating the adoption of ISO 50001. By thus comparing Figure 3 and Figure 4, one can conclude that the ISO 50001 process benefits an organization by fostering a culture of continuous improvement and energy efficiency awareness, which in turn makes it easier for management and the organization to execute future improvements.

Challenges

Interpreting analytical results for challenges faced during implementation, presented in Figure 5, dictates caution. 80% of the case studies mentioned at least one challenge, yet no single code was mentioned in more than one quarter of case studies that discussed any challenges, meaning that individual organizations discussed challenges to a lesser extent than other categories. Given that case studies were from facilities that attained ISO 50001 certification in order to receive an achievement award, it is expected that each organization will highlight successes rather than challenges. In addition, the EMWG template did not award points for discussing challenges specifically, relative to other items suggested in the "Lessons Learned" section, such as plans to replicate or expand ISO 50001 efforts at other sites, or solutions to challenges and measures for success.



Code	Description
INFO	Imperfect information; lack of disaggregated and transparent energy consumption data
EXP	Lack of in-house expertise; limited access to best practices and outside contractors with necessary expertise
CUL	Energy management not integrated/rewarded within company culture, nor is part of daily employee behavior
CEO	Lack of ongoing top management support
EMV	Challenges conducting EM&V, the energy review process, or energy accounting

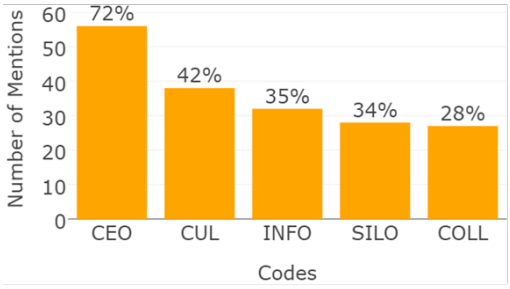
Figure 5: Challenges faced by organizations in implementing ISO 50001.

About one quarter of the case studies indicated insufficient energy consumption data as a major challenge. From EMWG awardees, this can take shape as a lack of availability, accuracy, and connectivity of power meters;

difficulties setting up or maintaining an effective monitoring system; issues surrounding energy data transfer, security, and confidentiality; and the challenge inherent to identifying and prioritizing major energy consumers. Next most common (22% of all case studies) were a lack of experience and in-house expertise with regards to ISO 50001 execution, as well as energy efficiency not being an integral part of the company culture, with the former outpacing the latter in terms of number of mentions. Participating companies identified gaps in expertise with respect to technical knowledge to manage energy, familiarity with ISO 50001 requirements and details of energy management systems, and finding a qualified accreditation body. Concerns about culture typically revolved around the challenges in sufficiently engaging plant personnel to motivate them to care about energy, institutionalizing necessary behavioural changes, and maintaining synergy and commitment throughout. Lastly, a lack of ongoing management support and challenges conducting energy measurement and verification were mentioned by 17% of all case studies. The former difficulty often involved overcoming management's initial disinterest or reluctance, driven by a narrow focus on increasing production, revenue, and profitability, as well as a lack of awareness of energy efficiency benefits for these targets. Common strategies to meet such a challenge were starting with no- and low-cost projects, positioning ISO 50001 explicitly as a way to meet strategic challenges, and showcasing smaller projects' success to ensure continued resource allocation.

Keys to Success

The term and content for "keys to success" is taken from the section of the EMWG case study template of the same name. The EMWG template recommends a bulleted format for the top tips and insights to help others successfully execute ISO 50001. Top keys to success can be seen in Figure 6. Strong management support was by far the most critical to successful uptake, as coded from almost three quarters of case studies. Developing an energy performance-focused culture with engaged employees received the second-most mentions and was key for 42% of participating companies. Next, more than one third of case studies analysed featured two additional keys to success: the availability of high-quality energy data and the reduction of departmental silos; the former was slightly more common by both metrics. Rounding out the top five, with nearly 30% of case studies and almost as many mentions as reducing silos, is working in collaboration with service providers, government, or implementation coaches to achieve a successful ISO 50001 EnMS.



Code	Description
CEO	Support from management; corporate-level program leadership
CUL	Existing culture of energy awareness; recognition that energy conservation is a responsibility and part of everybody's work
INFO	Reliable and accurate energy metering; understanding SEUs and identifying facilities with largest impact
SILO	Reduce departmental silos; create cross-functional energy teams; share required tools, frameworks, and information
COLL	Collaboration with service providers, government, or implementation coaches; access to guidance documents

Figure 6: Keys to success in implementing ISO 50001.

Looking more closely at case studies that emphasize strong support from management, it becomes clear that because instituting a systematic EnMS requires time as well as financial and human resources, for best results senior management should establish well-defined energy policies and targets, allocate appropriate resources, and stay interested and involved in the ISO 50001 effort. Mutua Madrileña's 2017 case study notes, "Top management provided up-front support to the EnMS, giving it strong initial thrust. However, it is continuous improvement and sustained performance that maintain and enlarge support and recognition." Second, multiple firms learned it is advisable to treat energy awareness as a mind-set integrated tightly into employee behaviours, instead of viewing the EnMS solely as a system implementation or merely as a formality. Next, case studies discussed energy data availability across various dimensions, including increasing knowledge of equipment and systems via real-time sub-metering, identifying significant energy uses to capture the best opportunities for energy efficiency investment, creating tools and databases that allow the evaluation of energy consumption in relation to certain variables, and having a direct link between operational control and monitoring phases, which allows informed decisions to be made based upon specific performance indicators. Measures taken to overcome organizational silos were also heterogeneous in nature, but often involved ensuring that dedicated energy teams were cross-functional and drawn from various departments; energy teams developing strong partnerships with finance departments; intensive (and sometimes top-down) communication; and sharing best practices between plants or facilities. Finally, participating

companies advised collaboration with outside actors such as external consultants, peer companies or municipalities, government energy agencies/ministries, or organizations like UNIDO, in order to access effective technical expertise, energy audits, and training programs.

Comparing Challenges and Keys to Success

Results from the "Challenges" and "Keys to Success" sections are perhaps more meaningful when compared side by side. Figure 7 summarizes all codes where those two categories overlap, and presents them in a tornado diagram. These codes are important to highlight because they are not only barriers to implementation, but can also be turned around to be used as an organizational strength for effective ISO 50001 adoption. In other words, themes represented here are vital to success—but also can be difficult to effectively harness. Note again that because the case study template placed little emphasis on challenges, the percentages for the bottom half of Figure 7 may understate impediments to successful EnMS adoption. Nearly three quarters of all case studies emphasized the necessity of top-level management support, with 17% identifying the same as a challenge. Relative to top management support, an energy-aware culture was next most prevalent as a key to success, but fostering such a culture was more often identified as a challenge than was securing management support. Next, gathering accurate and sufficient energy data was identified as key to success about as often as was reducing departmental silos through various measures—yet the difficulties in energy data and monitoring were encountered twice more often by participating organizations. Finally, specifically taking measures to increase employee awareness of energy can be viewed as complementary to creating an energy-aware culture; smaller shares of case studies identified this theme as both a challenge and a key to success.

Often seen were direct linkages between challenges experienced and advice for overcoming them. For example, HARBEC, Inc. mentioned that companies often perceive the initial upfront costs as a barrier to adopting ISO 50001, but "in [our] experience, however, the short- and long-term economic value of this project far outweighs the out-of-pocket expenses. The simple economic payback on this project was 2.4 years…[H]owever a number of high-value benefits…have achieved additional value to the business, including achieving carbon neutrality, reinforcing an eco-conscious business culture, and putting a process- and performance-based discipline in place for continuously driving resource efficiency and process improvements." In addition, Mutua Madrileña's initial financial qualms were not borne out: "When [we] first started implementing ISO 50001, we were sure it would need deep economic investment. Nearly two years later, everyone has been happily proven wrong…We have realized that saving energy makes strong commercial sense and this drives the support from the top."

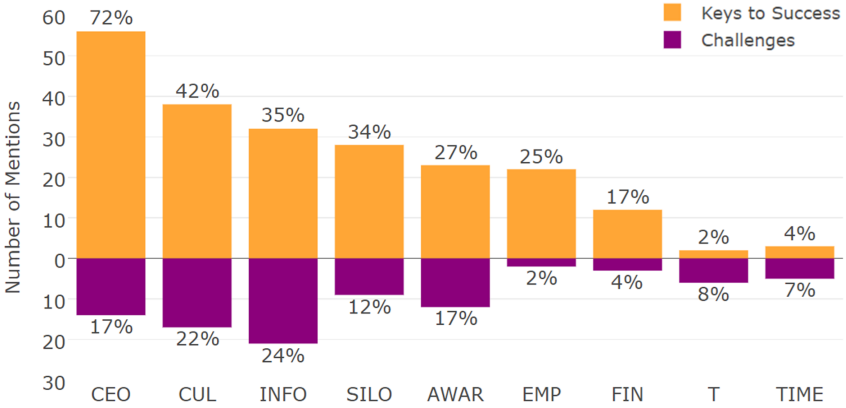


Figure 7: Analysis of overlap between "Keys to Success" and "Challenges".

Table 4. Descriptions of codes represented in Figure 7.

Code	Description - Keys to Success	Description - Challenges
CEO	Support from management; corporate-level program leadership	Lack of ongoing top management support
CUL	Existing culture of energy awareness; recognition that energy conservation is a responsibility and part of everybody's work	Energy management not integrated/rewarded within company culture, nor is part of daily employee behaviour
INFO	Reliable and accurate energy metering; understanding SEUs and identifying facilities with largest impact	Imperfect information; lack of disaggregated and transparent energy consumption data

SILO	Reduce departmental silos; create cross-functional energy teams; share required tools, frameworks, and information	Departmental silos; misaligned responsibilities & budgets; knowledge gap between departments
AWAR	Specifically take measures to increase employee awareness and improve transparency and reporting	Lack of awareness or failure to recognize benefits of systematic EnMS or non-energy benefits
EMP	Employees feel empowered and rewarded to take action	Lack of in-house expertise; limited access to best practices and outside contractors with necessary expertise
FIN	Commit sufficient resources; give program its own budget responsibility	Internal competition for capital
T	Minimize implementation time	Time commitment required for learning/implementation
TIME	Think on a longer time horizon, as energy management requires long-term planning	Managers stay in posts only a short time; short business time horizons

In many cases, a challenge assigned one code (e.g., FIN) would be resolved by a key to success coded differently (e.g., CEO). For example, changing the company culture to integrate energy management was a challenge met by specific actions to improve communication, awareness, and competencies at New Gold, Inc.'s New Afton Mine: "Support of the management team and the employees must be done face-to-face, talking to people and listening to their concerns. Let them know what this will do for them…Communication, training and awareness is the crux of the system." In addition, New Gold suggested utilizing external expertise to save time and frustration. Their concerns about the required time commitment were also mitigated by relying on systems already in place for communication, safety, and incident reporting: "Avoid reinventing the wheel for every initiative: piggyback where possible, on existing systems." Nissan North America, Inc. also faced a major challenge in "shifting the culture and convincing plant officials to invest in energy efficiency" because "some believed the company had already seized all opportunities to reduce energy usage." Here, the solution was found via better information from the EnMS and the EnPI tool provided by the U.S. Department of Energy, which together "enabled discovery of correctable, previously undetected energy losses."

Discussion and Conclusion

Since the ISO 50001 standard is so new, until recently there had been little evidence of a well-defined value proposition for instituting an ISO 50001 certified energy management system. The scarcity of data on motivations, barriers, and benefits to implementation—especially outside of Europe—has meant that it has been difficult to clearly communicate the business value of ISO 50001, especially since this standard can be implemented in heterogeneous organizations of all types, sizes, sectors, and geographic locations. Fiedler & Mircea (2012) assumed that cost savings was the chief driver for most companies, followed by government incentives and strengthening company image. In transcribing case studies, we find that certified organizations contending for Energy Management Leadership Awards undertook ISO 50001 adoption had a range of motivations and experienced myriad benefits. However, some commonalities have emerged. From this analysis, the biggest drivers for ISO 50001 certification are: existing values and goals, cost savings, environmental sustainability concerns, government incentives or regulations, and gaining competitive advantage via visibility. These are largely aligned with those from recent European surveys (AFNOR 2015/2017 and Marimon & Casadesús 2017).

Given these insights, policy makers may want to position ISO 50001 as a proven means to achieve existing energy and sustainability strategies while enhancing company image and competitiveness. Government incentives have also increased uptake, whether financial, regulatory, or through the provision of tools and expertise. Of these motivations, cost savings and improving environmental sustainability were commonly seen as benefits, and can be seen in Table 5 for the pool of companies that submitted case studies.

Table 5: Total annual savings from ISO 50001 energy management systems among Energy Management Leadership Award contenders.

Savings metric		2016	2017	total
Cost (€EUR million)		€61*	€146	€207
Energy	(petajoules)	4.9	51	55.9
	(billion Btu)	4,644	48,340	52,984
CO_2 emissions reduction (million metric tons)		0.92**	5.8	6.72

Equivalent number of passenger vehicles removed from the road each year (million)	0.2	1.2	1.4
Number of case studies	35	37	72
* *Several organizations did not report energy savings in their 2016 case studies* ** *Several organizations did not report CO_2 emission savings in their 2016 case studies*			

Participating companies also increased productivity via less plant downtime, higher capacity, and/or better energy intensity, or by automating energy monitoring or management processes, which yielded time and resource savings that may not be included above. Finally, ISO 50001 was valuable in terms of establishing a systematic framework for organizations to integrate energy efficiency throughout their facilities and daily operations. It also facilitated a culture of continuous improvement that strengthened employee motivation and company culture. All of these benefits provide business value, even those less quantifiable.

In comparing the role of management and the organization and keys to success, we see that top management support is critical to an effective EnMS, so policy makers should focus on making the case for ISO 50001 to this stakeholder group. Commitment and ongoing interest from top management help ensure that the implementation process has the resources it needs. Moreover, management can optimally structure this effort to transcend company silos by establishing cross-functional teams and ensuring that lines of communication between departments and facilities are clear. Actively taking measures to increase employee awareness is vital in advancing a culture of energy conservation, while conducting trainings and gathering detailed and accurate energy data—both often in concert with outside implementation coaches, service providers, or government entities—equip an organization's workforce to effectively manage energy use and strive for the continuous improvement that is the hallmark of ISO 50001.

Steps to further this work are forthcoming. External contributors will be brought in to code all case studies independently from the initial researchers involved, which will allow the determination of a more robust metric of inter-coder reliability. When 2018 case studies have been submitted (deadline of 24 January 2018) and scored, they will be incorporated into the pool of 2016 and 2017 case studies and analysed using the same framework. The addition of the 2018 case studies may allow for industrial subsector disaggregation, shedding light on differences within the industrial sector. Next, an online database of results will be developed that will highlight non-energy benefits and compelling quotes from case studies. The database is intended to be structured such that users can search and display records pertaining to specific sectors, countries, and years. An increasing number of case studies in various sectors and countries will allow for more robust examination of whether certain drivers, benefits, or challenges are correlated with these parameters. The principal goal of the online database with up-to-date results is to facilitate improved messaging to specific stakeholder groups and, ultimately, to quicken uptake of ISO 50001 energy management systems.

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